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ABSTRACT

The document is one of seven volumes of instructional materials developed around a cluster of Transportation Industries. Primarily technical in focus, they are designed to be used in a cluster-concept program and to integrate with a regular General Education Development (G.E.D.) program so that students may attain an employable skill level and a general academic background simultaneously. They provide basic skills necessary to enter a number of occupations in the Transportation cluster rather than an indepth development of skill in any one occupation. The volume contains approximately 120 hours of instruction in Farm and Earthmoving Equipment and consists of 20 instructional units, each having one or more specific lessons. Each unit is designed for six hours, or one day, of instruction: three hours of technical laboratory instruction and three hours of related study in science, math, communications, and social studies. In most cases, there is only one lesson per unit. The units offer the instructor the essential materials: the aims (both in technical areas and in the four general education areas), instructional aids, topical outline and activities, suggested time sequence, evaluation guidelines, summary, and references. A selected bibliography concludes the volume. (Author/AJ)

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Commonwealth of Pennsylvania

Department of Justice

Bureau of Correction

VOCATIONAL EDUCATION
PROGRAM OF STUDIES

Elementary, Secondary Education Act

Title I

TRANSPORTATION CLUSTER

VOLUME VI

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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January 1, 1971

Pennsylvania Bureau of Correction

Harry A. Snyder

Director of Education

INTRODUCTION

The following information comprises one of seven volumes of instructional materials developed around a cluster of Transportation Industries and Occupations. These instructional materials are primarily technical in focus but are written to be used in a cluster concept program as part of an integrated curriculum.

The materials are aimed at preparing students with basic skills necessary to enter a number of occupations in industries within the Transportation cluster rather than providing an in-depth development of skill in any one occupation.

Each volume contains approximately one hundred twenty hours of instruction (about one month of study) and consists of twenty instructional units each having one or more specific lessons. Each unit is designed for six hours of instruction (three hours of technical laboratory experiences and three hours of related study in science, math, communications and social studies) but may be varied at the instructor's discretion.

The seven volumes or cluster areas in the series are:

Volume I - Automotive Services I
II - Automotive Services II
III - Small Power Sources
IV - Driver Training
V - Pneumatics, Hydraulics and Fluidics
VI - Farm and Earthmoving Equipment
VII - Transportation Systems

Students in the Transportation cluster should be introduced to the technical and integrated content through several methods closely related to the industrial structure. Among these are line production and assembly, group projects, experimentation, unit studies and independent study. Team teaching techniques should be employed between the academic specialist and the technical specialist and coordinators.

It is recommended that an orientation program be offered students to familiarize them with the cluster areas available so they may select one they wish to pursue. The cluster instruction is designed to integrate with the regular G. E. D. program so that students may receive an employable level of skill and a general academic background simultaneously.

As students select the technical cluster areas they wish to study, they should have the option to move through the G. E. D. content at their own speed using programmed instructional materials, instructional television, computer assisted instruction and other individualized learning techniques. Technical and integrated concepts are introduced each day by the specialists involved.

After completion of one or more months of study within another cluster providing, of course, this transfer is agreeable with the counselors, coordinators and instructors involved.

Lessons have been identified in the units. In most cases, however, there is only one lesson since each unit is limited to one day or six hours of instruction. The units offer the instructor the essential materials, vis-a-vis the aims, instructional aids, topical outline and activities, suggested time sequence, evaluation guidelines, summary and references. The primary and supplemental references are directly related to the topics and are important to the instructors. A selected bibliography is attached at the end of each volume as recommended additional sources of information.

Pagination of the units in this volume has been identified by cluster (T), volume (I, II, etc.), unit (1, 2, etc.) and page (.1, .2, .3, etc.) within each unit.

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INSTRUCTOR'S UNIT PLAN

Unit 1
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Introduction to Farm Machinery, Identification and General Overview**

AIM: To produce, in the student, an understanding of the use, care and safe operation of modern farm machinery.

INSTRUCTIONAL AIDS:

Film - **Three Generations**. Vernard Film Distribution Service, 113 North East Madison Avenue, Peoria, Ill. 61602.

EQUIPMENT:

16 mm projector and screen.

PRIMARY REFERENCES:

1) Cook, Glenn C. et al., **Farm Mechanics Text and Handbook**, Danville, Ill.: Interstate Printers & Publishers, Inc., 1959.
2) Smith, Harris P., **Farm Machinery & Equipment**, New York: McGraw-Hill Book Company, 1964.
3) Turner, A. W. and Johnson, E. J., **Machines for the Farm, Ranch and Plantation**, New York: McGraw-Hill Book Company.

I. INTRODUCTION and MOTIVATION

A. Show film (which shows the use of modern farm machinery). Discuss the productivity of today's modern American farm and the tremendous use of farm machines in today's American agriculture.

II. PRESENTATION of INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Definition of farm machinery.	1. Role of farm machine in crop production. 2. Naming farm machinery. 3. Placing farm machines in use categories. 4. Defining requirement for use of farm machines.	1. Characteristics of the soil and its composition. 2. Characteristics of crops. 3. Outline of general planting and crop growing procedures.
B. Construction requirements of farm machinery.	1. Construction of farm tractor. 2. Capabilities of farm tractor. 3. Attachment of implements to farm tractor. 4. Adjustment of implements (hydraulic system) to tractor. 5. Adjustment of implements in ground contact. 6. Adjustment of implements in crop contact. 7. Construction of farm machines to conform to ground surfaces. 8. Self-propelled machines.	1. Mechanical advantage. a. Levers b. Wheels c. Pulleys d. Belts e. Friction f. Fluids and hydraulics g. Pressure h. Tension i. Transmission of power
C. Use of farm machinery.	1. Use of prime mover (tractor). 2. Naming and use of earth-tilling equipment. 3. Naming and use of crop planting equipment. 4. Naming and use of cultivating, spraying and other crop environment control devices. 5. Naming and use of harvesting farm machinery. 6. Naming and use of lifting, hauling and storing farm machines.	1. Principle of action of moldboard plow. 2. Principle of action of discs and harrows. 3. Principle of action of spray devices. 4. Principle of action of cutting devices. 5. Prinicple of action of hydraulic piston.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Simple measurements. a. English system . . . units b. Metric system . . . units	1. Reading and discussing information brochures and pamphlets.	1. Evolution from hand and animal farm labor to machine use. 2. Construct a time line depicting the major developments in the emergence of machine use.
1. Figuring ratios, distances, pressure ratios and compression ratio.	1. Reading charts and graphs. 2. Reading instruction manuals.	1. Discussion of the impact of farm machine requirements on industrial production. 2. Discussion of the farm machine user as a consumer of industrial products. 3. Discussion of engineering advances as applied to farm machines.
1. Principle of action of wedge. 2. Calculating mechanical advantage. 3. Calculating cubic measure and weight ratios. 4. Calculate lifting force of hydraulic pistons.	1. Discuss value of lifting machines to simple manpower. 2. Discuss use of higher and larger storage buildings due to machine use. 3. Discuss use of larger machine due to power assisted machine movements.	1. Discussion of economic effect of man hours per production unit change since advent of farm machine use. 2. Discussion of social status change of American farmer since advent of labor-saving farm machine. 3. Discuss value of farm property since advent of farm machine use. 4. Discuss costs per unit produced since advent of farm machine use. 5. Discuss relationship of the development of large farms and the diminishing number of smaller farms. Analyze the above in light of the development of sophisticated farm machinery.

III. APPLICATION

A. Students will be instructed in this unit mainly about the change from hand and animal power farming to the modern machine oriented farm.

B. The identification and purpose of the basic farming machines will be understood.

C. The operating principles of each machine and its relationship to the crop or job done is to be defined.

D. The change in the farm social structure as a result of mechanization is a fact to be well discussed.

IV. EVALUATION CRITERIA GUIDELINE

A. Why has the mechanization changed the American farm?

B. Why must the modern farm operator be skilled with machines?

C. How have costs of production changed since the advent of farm mechanization?

D. Where can a farmer learn about machine maintenance and operation of his farm machinery?

V. SUMMARY

A. The farm operator today is faced with the job of maintaining and operating a large variety of complicated farm machines. His skill and intelligent use of this machinery can affect the financial success of his operation. He must understand the operating principles and use his machinery to its maximum capacity.

VI. SUGGESTED TIME and SEQUENCE LISTING

100 minutes . . . Film and introduction to subject.

60 minutes . . . Technical concepts.

60 minutes . . . Math.

60 minutes . . . Science.

20 minutes . , . Communications.

40 minutes . . . Social studies.

20 minutes . . .Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Barnard, J. Darrell, **Science: A Key to the Future,** New York: The Macmillan Company, 1962.

2) Hunt, Donnell, **Farm Power and Machinery Management,** Ames, Iowa: Iowa State University Press.

3) Local County Agent.

4) United States Department of Agriculture, Washington, D. C.

5) List of major-line agricultural machine manufacturers where teaching aids may be obtained.

A. Service Department
Tractor and Implement
Ford Motor Company
2500 East Maple Road
Birmingham, Michigan

B. J. I. Case Company
Racine, Wisconsin

C. International Harvester Co.
180 N. Michigan Ave.
Chicago, Ill.

D. Oliver Corporation
400 W. Madison
Chicago, Ill.

E. Allis-Chalmers Corporation
Milwaukee, Wisconsin

F. Massey-Ferguson Inc.
Indianapolis Training Center
6143 Brookville Road
Indianapolis, Ind.

G. John Deere and Company
Moline, Ill.

H. Service Department
Minneapolis-Moline
Hopkins, Minnesota

INSTRUCTOR'S UNIT PLAN

Unit 2
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Farm Machine Safety**

AIM: To develop safe operating techniques for operation and maintenance of farm equipment.

INSTRUCTIONAL AIDS:

Kit - Tractor Overturn Prevention and Protection Kit (TOPP) Kit - National Safety Council, Chicago, Ill.
Kit - FFA Tractor Safety Kit - National Safety Council, Chicago, Ill.
Appropriate Operators Manuals.
Film - **Farm Tractor Safety,** Extension Service Library, Auburn, Alabama.

EQUIPMENT:

16 mm projector and screen.

PRIMARY REFERENCES:

1) Cook, Glenn C. et al., **Farm Mechanics Text and Handbook**, Danville, Ill.: Interstate Printers & Publishers, Inc., 1959.

2) National Safety Council, 425 North Michigan Avenue, Chicago, Ill. 60600.

I. INTRODUCTION and MOTIVATION

A. Using current figures and statistics obtained from National Safety Council explain the cost in human life and economic loss of farm equipment accidents.

B. Explain why the operation of farm machinery produces the high accident rate recorded.

C. Identify the most dangerous aspects of farm machine operation.

II. PRESENTATION of INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Starting machine safety.	1. Correct belt tensions. 2. Drive shafts correctly aligned and secured. 3. Spring tensions correct. 4. Safety guards aligned and in place. 5. Fluid levels correct. 6. Hydraulic lines secured and sound. 7. Safe fueling procedures.	1. Explain Newton's Laws of motion. 2. Show out-of balance wheel vibration and danger of breaking moving parts. a. Centripetal force b. Centrifugal force
B. Operating machine safety.	1. Correct adjustments of machine to give safe and efficient speed. 2. Reasons for use of governor on farm machinery. 3. Danger of excessive speed to farm machines. 4. Show how lubrication is lost with excessive operating speed.	1. Show stress produced by excessive speed and momentum. 2. Increased heat production with speed. 3. Friction reduces available horsepower.
C. Stopping machine safety.	1. Check machine over for leaks, worn belts, etc., before shutdown. 2. Inspect to see that no flammable material is in contact with hot machine parts. 3. Locking brakes and restraining devices to secure machine.	1. Discuss flash points of fuels. 2. Storage of fuels. 3. Spontaneous combustion.
D. Operator safety habits.	1. Safe clothing. 2. Safety attitude. 3. Responsible conduct in machine operation.	1. Human reactions to stress. 2. Machine design to reduce fatigue. 3. Machine noise and vibration on human body.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Explain torque, RPM (rotations per minute), speed. 2. Dangers of momentum. a. Definition b. Calculation of momentum	1. Read operator manual. Read sections on safety of operation.	1. Discuss why farm accidents have increased with increased use of modern farm machinery. 2. Discuss cost of accidents to farmer, community, nation. 3. Identify implications for needed programs in educating user of farm machinery. a. Stringent legislation in construction work and mining.
1. Show increased operating cost due to breakdowns, excessive fuel use, loss of lubricating materials. 2. Develop graphs to relate driver fatigue with accidents.	1. Read and identify operating temperatures, fluid levels, hours of operation, belt and spring tensions. 2. Discuss driver fatigue. 3. Discuss operating machines in closed buildings, etc. (usually warned about in operator's manual).	1. Discuss hospital costs due to accidents. 2. Discuss insurance costs and policies.
1. Record operating costs. 2. Show how increased speed and dangerous operation can add to costs.	1. Read and discuss shutdown and storage sections of operator's manual.	1. Discuss how community, state and nation can aid farmer to operate a safer business. a. Education
1. Determine attention span for machine operation. 2. How long can a man operate a farm machine safely?	1. Does the machine operator read and understand all the written literature related to the farm devices he operates?	1. How has the farm machine changed the living patterns of farm workers? 2. How can the modern farm be made safer?

III. APPLICATION

Students should discuss and be made to realize that farm machines are only as safe as the operator. A farm machine can give many years of excellent, safe work as long as the operator respects and operates the machine, always conscious of its dangers.

IV. EVALUATION CRITERIA GUIDELINE

A. What is safe machine operation?

B. What does a safe operator do to prevent accidents?

C. Who is responsible for safe farm machine operation?

D. Why is safety so important to a farm operation?

V. SUMMARY

A. One of today's most dangerous occupations is farming. The reason for this is the very great use of high horsepower machines in potentially dangerous situations (hills, rough ground, out of doors in bad weather, all season operation, etc.). The machines themselves, because of the work they are to perform, are basically dangerous. Example: high center of gravity, exposed belts and drive shafts.

B. The modern farm machine operator must understand his machine and do all in his power to operate it carefully.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Introduction.

180 minutes . . . Lab experience in checking and describing safety procedures dealing with farm machines (using operator's manuals).

40 minutes . . . Math concepts.

40 minutes . . . Social studies.

40 minutes . . . Science concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Beiser, Arthur, **Basic Concepts of Physics**, Reading, Mass.: Addison-Wesley Publishing Company, Inc., 1961.

2) Hall, Raymond C., **Demonstrate Farm Tractor Safety . . . Better Farming Methods**, October 1956.

3) Rush, John D., **Fatal Farm Accidents, United States**, 1949-53, Agricultural Research Service, USDA, May 1957.

4) **They Die So Young** (Fatal tractor accidents by age groups), National Safety Council.

5) **Tractor Facts! Farm Machinery Accident Fatalities and Tractor Traffic Accidents.**

INSTRUCTOR'S UNIT PLAN

Unit 3
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM AND EARTHMOVING EQUIPMENT

SUBJECT: **Basic Tractor Maintenance, Pre-operation and Check Out**

AIM: To develop the skills and attitudes necessary to operate and maintain a farm tractor.
To cut operating costs by reducing major replacement and repairs.

INSTRUCTIONAL AIDS:

Farm tractor (any available make). Tractor manual.
Filmstrip - **Tractor Operation and Daily Care**, 704 Fairlie Street NW, Atlanta, Georgia 30303: Colonial Films, Inc. (Set of 4, $22.00, color).

EQUIPMENT:

Filmstrip projector, screen, drive socket sets - ⅜" and ½", assorted hand tools: Pliers, screw drivers, hammers, etc., grease gun, oil can and lubricants, open end and box end wrench set.

PRIMARY REFERENCES:

1) Brown, Arlen D. and Morrison, Ivan G., **Farm Tractor Maintenance**, Danville, Ill., Interstate Printers and Publishers Inc., 1962.

2) **Tractor Maintenance Principles and Procedures**, AAVIM Engineering Center, Athens, Georgia 30601.

3) **Tractor Operation and Daily Care**, AAVIM Engineering Center, Athens, Georgia 30601.

I. INTRODUCTION and MOTIVATION

A. Show filmstrip, **Tractor Operation and Daily Repair**. Follow by taking class to shop and explain the operating principles and how to read the operating manual of farm tractor in shop. Give short rundown on shop safety and use of tools.

II. PRESENTATION OF INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Starting farm tractor checks	1. Check radiator liquid level. 2. Check oil level. 3. Check tire pressure. 4. Check fuel level. 5. Check gauges after starting engine. 6. Check brakes and steering operation. 7. Make visual inspection for leaks.	1. Discuss how internal combustion engine is cooled. a. Water cooled b. Air cooled 2. Friction and lubrication.
B. Daily farm tractor checks after 1 day operation)	1. Check battery acid level. 2. Clean air passages in radiator or air vanes in air-cooled engine. 3. Check nut and bolts for tightness. 4. Test belt and spring tension.	1. Reading battery hydrometer for specific gravity. 2. Determining boiling points of liquids. a. Effect of pressure on boiling b. Effect of density on boiling 3. Checking air flow through closed ducts.
C. Operating an hourly maintenance system.	1. Grease all fittings. 2. Change engine oil. 3. Change all filters and breathers. 4. Adjust or replace plugs, points, injectors, and parts rated by hourly use. 5. Adjust belts and springs.	1. Discuss loss of power by slipping belts. 2. Discuss poor electrical conducting capacity of dirty points, plugs, poor wiring.
D. Practicing seasonal maintenance.	1. Check antifreeze readings. 2. Replace or maintain tires, etc. 3. Spot paint. 4. Adjust and repair hitches used for seasonal equipment. 5. Remove or attach seasonal units (cabs or heaters, etc.) as season dictates.	1. Reading antifreeze hydrometer. 2. Discuss freezing points of water and antifreeze solution. 3. Discuss antifreeze capacity of calcium chloride in liquid-filled tires.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measurement (gallons, quarts, etc.). 2. Pressure (pounds/sq. in.). 3. Temperature. a. Chart temp. of water heated to boiling b. Chart temp. of water chilled to freezing	1. Reading operators manual for correct levels and pressures. 2. Reading charts and graphs.	1. Discuss the economics of machinery ready for work or broken down and useless, as related to the nation's potential agriculture output.
1. Determining costs of operating farm machinery. 2. Determining costs of maintaining farm machinery.	1. Reading temperature operating charts. 2. Reading instructions for measuring lubricants.	
1. Calculate man hours maintenance to machine operating hours.	1. Reading maintenance charts and locating units to be serviced.	
1. Determine depreciation of farm machinery. 2. Determine initial cost. 3. Determine value of product produced to cost of operating farm machine.	1. Read cost of operation figures. 2. Discuss man labor vs. machine labor.	1. Determine how much more productive a man plus machine is compared to manpower alone. How could the addition of sophisticated farm machinery assist in the growth of emerging underdeveloped nations?

III. APPLICATION

A. Students will start by doing daily checks on farm tractor, then proceed to hourly and seasonal checks. Students will keep records of time, quantity of servicing materials used, and parts. Neatness and orderly work should be stressed.

IV. EVALUATION CRITERIA GUIDELINE

A. Why is maintenance necessary?

B. Why is time and labor expended on machine maintenance cheap insurance?

C. Why is fixing a machine before it breaks good economics?

D. Why should a farm machine operator know basic machine maintenance?

V. SUMMARY

A. By keeping a farm tractor in efficient operating condition, the operator has a ready tool to make his work easier. Lack of maintenance and observant care reduces the reliability of a tractor and often renders the machine inoperative when it is needed the most.

VI. SUGGESTED TIME and SEQUENCE LISTING

220 minutes . . . Lab.

40 minutes . . . Math.

40 minutes . . . Science

20 minutes . . . Social studies.

20 minutes . . . Communications.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Farm Tractors: Basic Principles, Operation and Maintenance.** New York: Engineering Bulletin No. FT53, American Oil Company (no charge).

2) **Ford Tractor Shop Manual.** Dearborn, Mich.: Tractor and Implement Division, Ford Motor Company.

3) **Gulf Tractor Guide.** No. SP10293, Houston, Texas: Gulf Oil Corporation, Gulf Building (no charge).

4) **Management Course in Dealer Service Occupations.** Indianapolis, Indiana: Massey-Ferguson Training Center (no charge).

5) Osborn, Jesse O., **Mathematics for Daily Needs.** New York: Webster Publishing Company, Division of McGraw-Hill Book Company, 1960.

6) **Piston Rings, Pistons and Cylinders,** Form 2013, Hagerstown, Indiana: Perfect Circle Corporation, 1963 (no charge).

7) **Tractor Maintenance Principles and Procedures,** Athens, Ga.: American Association of AG Engineering and Vocational Agriculture.

INSTRUCTOR'S UNIT PLAN

Unit 4
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: Tractor Operation

AIM: To develop a safe, efficient farm tractor operator.

INSTRUCTIONAL AIDS:

Large bulletin board or piece of plywood on legs which can be used as instruction board in the field. Wocden stakes 2"x2"x4' long. Lime to mark stop lines, lanes, etc.

EQUIPMENT:

One farm tractor (checked out and in good working order).

PRIMARY REFERENCES:

1) O'Brien, Michael, **Demonstrations for Farm Mechanics**, Danville, Ill.: Interstate Printers & Publishers, Inc., 1957.

2) **Operation, Care and Repair of Farm Machinery, The**, Moline, Ill.: Deere and Company, 1957, 28th Edition.

3) Sneep, Neil O., **Safe Tractor Operation, Safe Farm Machine Operation**, East Lansing, Mich.: Michigan State University (Special Paper #8)

I. INTRODUCTION and MOTIVATION

A. Take students to field; have a field course outlined and prepared for students to show proficiency in simple tractor operation.

B. Instructor will demonstrate mounting and operation of tractor, followed by student operators demonstrating proficiency.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Starting prechecks.	1. Check fuel. 2. Check oil level. 3. Check water level. 4. Check tires. 5. Check for bolts or connections. 6. Check operator's clothing.	1. Types of tractor fuel. 2. Efficiency of various tractor fuels. a. Fuels as mixtures of hydrocarbons b. Oxidation of fuels.
B. Preoperational adjustments.	1. Adjust seat. 2. Principles and effect of front and rear wheel spacing. 3. Adjustment of control arms and levers. 4. Principle and effect of adding weights.	1. Levers and power multipl[illegible] 2. Friction. 3. Balance. 4. Center of gravity and related safety problems.
C. Starting engine.	1. Operating in open area. 2. Gear shift in neutral. 3. Using choke and throttle. 4. Starting practice. 5. Using brake and clutch pedals. 6. Shutting off engine.	1. Engine speed related to gear ratios. 2. Mechanical advantage of various size drive wheels.
D. Operating tractor.	1. Gear selection. 2. Engine speed. 3. Load conditions. 4. Making turns. 5. Starting and stopping. 6. Backing the tractor. 7. Estimating distances. 8. Following lines and boundries. 9. Parking the tractor. 10. Cutting off power. 11. Practicing for precision control. 12. Developing speed and efficiency.	1. Speed related to work efficiency. 2. Design of steering wheel and controls for efficient operation. 3. Visibility for safe tractor operation.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Figure tank capacity by its dimensions.	1. Reading capacity levels. 2. Reading and understanding warnings on safety devices.	1. Develop an awareness on the part of the student for his responsibility for safe farm tractor operation. 2. Review regulations for tractor operation on public and private property. 3. Discuss the need for state laws regulating operation of farm tractors.
1. Figure increase of ground pressures on tires according to weights added.	1. Reading operator manual for positions and adjustments.	
1. Figure ground speed calibrated to RPM of wheels. 2. Figure distance traveled. 3. Calculate feet of row to be traveled.	1. Reading operator's manual for gear ratios matched to power requirements.	
1. Calculate machanical advantage of steering wheel. 2. Calculate gear and axle ratios. 3. Calculate horsepower of tractor.	1. Reading and understanding state regulations for tractor operation on public roads.	

III. APPLICATION

A. Students practice and demonstrate safe tractor starting, driving and stopping.

IV. EVALUATION CRITERIA GUIDELINE

A. What are basic principles of safe farm tractor operation?

B. What value are pre-starting checks?

C. What must operator observe before putting machine in motion?

V. SUMMARY

A. Safe tractor operation takes a combination of clear background information on the functioning of the tractor systems, organized practice and responsible attitudes toward the use of this powerful tool.

VI. SUGGESTED TIME and SEQUENCE LISTING

240 minutes . . . Lab (tractor operation).

40 minutes . . . Science.

20 minutes . . . Math.

20 minutes . . . Communications.

20 minutes . . . Social Studies.

20 minutes . . . Summary and Evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Farm Tractors,** Engineering Bulletin FT-535, Standard Oil Division, American Oil Company, February, 1968.

2) **Leaders Manual and Demonstration Guide,** 4H Tractor Program, National 4H Committee Inc., Chicago, Ill. (Also 4H Extension Agents at County Seats).

3) Smith, Harris P., **Farm Machinery & Equipment,** New York: McGraw-Hill Book Company, 1964.

4) **State Vehicle Operators Rules and Regulations,** Local Police.

INSTRUCTOR'S UNIT PLAN

Unit 5
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Attachments and Adjustments of Implements**

AIM: To produce in the student the ability to attach and adjust modern 3-point hitch implements to the farm tractor. To understand hydraulic operation of certain implements.

INSTRUCTIONAL AIDS:

Film - **Farm Tractor Safety,** Film Library, Roberts Hall, Cornell University, Ithaca, New York 14850 (showing incorrect hitching).

EQUIPMENT:

16 mm projector, screen, tractor with 3-point hitch, one (1) piece of drawn equipment (drawn moldboard plow), one (1) piece of PTO driven equipment (baler) and one (1) frontend-loader (hydraulic rams)

PRIMARY REFERENCES:

1) Cook, Glenn C. et al., **Farm Mechanics Text and Handbook,** Danville, Ill.: Interstate Printers & Publishers, Inc., 1959.

2) Smith, Harris P., **Farm Machinery & Equipment,** New York: McGraw-Hill Book Company, 1964.

3) Stone, A. A. and Gulvin, H. E., **Machines for Power Farming,** New York: John Wiley & Sons, Inc., 1967.

I. INTRODUCTION and MOTIVATION

A. Show movie on safe hitching and operation of farm machinery. In shop, demonstrate correct techniques.

II. PRESENTATION of INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Farm tractor hitches.	1. Draw bar. 2. Three-point. 3. Integral center mounted. 4. Integral front mounted.	1. Force vectors (straight pull less horsepower usage). 2. Levers. 3. Inclined plane. 4. Wedge. 5. Screw (mechanical advantage).
B. Hitch movement and adjustment.	1. Lever arm action. 2. Cam and gear. 3. Hydraulic pumps. 4. Hydraulic cylinders (remote, integral). 5. Depth control.	1. Hydraulic principles. 2. Mechanical advantage. 3. Materials used in hitches. 4. Calculation of work.
C. Power transfer after hitching.	1. Power take-off shaft. 2. Hydraulic slave cylinders.	1. Power transmission through shaft. 2. Ball and roller bearing use. 3. Friction.
D. Hitching safety.	1. Use correct pins and clips. 2. Secure all guards on power take-off shafts. 3. Care in driving and backing implements. 4. Operator movements around operating machinery. 5. Careful operation of tractor controls for drawn implements.	1. Turning radius. 2. Momentum.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measure distances (English and Metric system). 2. Compute mechanical advantage.	1. Read tractor and implement operator's manuals.	1. Study the historical development from horse-drawn to tractor-drawn implements.
1. Measure and align implement clearances.	1. Read implement operators manual for adjustments.	1. Adjustment changes from horse-drawn to tractor-drawn equipment.
1. Calculate rotation per minute of shafts. 2. Calculate gear ratios and reduction of speed.	1. Read and identify safety warning stickers on machines, tractors and power take off shafts.	1. Increased horsepower tractors provide greater capacity for greater economy.
1. Measure clearances of attached implements.	1. Discuss the use of safety guards. 2. Determine and report on tractor accidents involving attached and drawn implements.	1. Discuss the value of tractor and implement safety to the community, e. g., man hours lost, personal injury, economic impact on families of the injured, etc.

III. APPLICATION

A. Students are introduced to parts and operation of tractor and implements in shop. Students read manuals and attach implements. Implement running is demonstrated. Students maintain, lubricate, detach and store implements.

B. Due to short instruction time, students do not operate implements under field conditions.

IV. EVALUATION CRITERIA GUIDELINE

A. Why is PTO shaft so dangerous?

B. How are revolving shafts, belts and pulleys protected?

C. Why are flexible mountings and universal joints on PTO shafts used?

D. What is the PTO shaft speed on a tractor?

E. What type of work does the hydraulic cylinder perform best?

F. Why are sharp turns dangerous when pulling drawn equipment?

V. SUMMARY

A. Farm tractor drawn and mounted implements come in a great variety of shapes and dimensions. The universal 3-point hitch is a common unit on most all makes of today's tractors. Most implements can be drawn by any make of tractor.

B. The important point is that many implements require certain horsepower to operate them and the tractor to operate them must have this capacity.

C. As with all machinery, the operator must maintain and operate the implement with care in order for the machine to do its best work.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Movie and introduction.

180 minutes . . . Lab.

40 minutes . . . Science.

40 minutes . . . Math.

40 minutes . . . Related concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1. Local County Agent.

2. United States Department of Agriculture, Washington, D. C. aids may be obtained.

3. List of major-line agricultural machine manufacturers where teaching

SEE PAGE T-VI-1.5

INSTRUCTOR'S UNIT PLAN

Unit 6
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Moldboard and Disc Plows: Adjustment and Use**

AIM: To provide to the student, a basic knowledge of the attachment and adjustment of moldboard and disc plows. To operate the tractor-mounted plow in such a manner as to demonstrate the turning of a correct furrow.

INSTRUCTIONAL AIDS:

Chart and diagrams of moldboard and disc plows, from local machine dealer.

EQUIPMENT:

One tractor, one mounted-type moldboard plow for tractor, one drawn-type moldboard plow for tractor and one mounted-type disc plow for tractor.

PRIMARY REFERENCES:

1) Cook, Glenn C. et al., **Farm Mechanics Text and Handbook,** Danville, Ill.: Interstate Printers & Publishers, Inc., 1959.

2) **Moldboard Plows,** Bulletin 2172, Washington, D. C.: United States Department of Agriculture.

3) Smith, Harris P., **Farm Machinery & Equipment,** New York: McGraw-Hill Book Company, 1964.

I. INTRODUCTION and MOTIVATION

A. Show charts and graphic views of plows. Identify and name parts of plow. Attach plow to tractor and demonstrate preliminary adjustments on the shop floor, then make final adjustments in the field. Student operation of tractor and plow should culminate this subject.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. The moldboard plow.	1. Parts of the moldboard plow. 2. Types of plow bottoms. 3. Operating principles of moldboard plow. 4. Attachment of plow to tractor (first drawn plow, then mounted). 5. Adjusting plow to tractor.	1. Soil types and plow adapted for each. 2. The inclined plane and its relation to moldboard plow. 3. Horsepower necessary for drawing a plow. 4. Relate tractor speed and soil turning producing good coverage.
B. The disc plow.	1. Parts of the disc plow 2. Operating principles of the disc plow. 3. Attachment of disc plow to tractor. 4. Adjusting disc plow to tractor.	1. Calculate horsepower to operate disc plows. 2. Different seed bed produced by disc plow. 3. Type of soil adapted to disc plows.
C. Field operation and adjustment of the moldboard plow (mounted and drawn).	1. Safe plow operation demonstration. 2. Adjust draft. 3. Adjust depth. 4. Adjust vertical hitch. 5. Adjust coulter. 6. Adjust landside wheel. 7. Operate plow. 8. Check for good turning and coverage of furrow. 9. Check straight clean furrow wall.	1. Correct straight line. 2. Adjustment uses less horsepower. 3. Principle of trip beam. 4. Principle of spring release. 5. Momentum and safety. 6. Covering vegetation for better bacterial decomposition.
D. Plow maintenance lubrication and storage.	1. Check all bolts and attachments for tightness. 2. Lubricate all fittings. 3. Sharpen shares or replace. 4. Check safety releases or trip bottom springs. 5. Cover share, moldboard and other bright parts with grease before storage.	1. Need to keep plow bottom rust-free. 2. Soil friction. 3. Plow suction. 4. Excessive wear due to loose connections.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measure size of field. 2. Calculating acreage. 3. Calculating time requirement for plowing.	1. Read instructions and operator's manual.	1. History of plow. 2. Ancestors of modern plow. 3. Importance of the plow to the growth of civilization. 4. Types of primitive plow in use today. Reasons for continued use. Status among world powers of countries confined to their use. 5. Sources of power for plows. a. Past b. Present
1. Measure plow depth. 2. Measure top soil depth.	1. Read instructions and operators manual.	
1. Force vectors.	1. Explain how plow works. 2. Demonstrate and explain how to make adjustments.	
1. Cost of plows. 2. Depreciation. 3. Life used factors.	1. Follow instructions of operator's manual on servicing and storing of moldboard or disc plow.	

III. APPLICATION

A. Use the moldboard plow as a basic instructional tool. Field operation and adjustment will follow the naming and parts identification section. After operation, the storage phase of use should be taught.

IV. EVALUATION CRITERIA GUIDELINE

A. Under what conditions are disc plows used?

B. Name and describe two types of plows.

C. What is necessary to do an even job of plowing?

D. How would you obtain the proper hitch adjustment?

E. What is the basic operating principle of the moldboard plow?

V. SUMMARY

A. The basic land tillage instrument is the moldboard plow in modern agriculture. Man through the ages has used all types of devices to till the soil, but the modern plow does an outstanding job. As with all farm machinery, knowledge of parts and their maintenance and operation are necessary for a good job.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Introduction.

240 minutes . . . Lab (field operation).

40 minutes . . . Related concepts.

40 minutes . . . Summary and evaluation (field proficiency test).

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

SEE PAGE T-VI-1.5

INSTRUCTOR'S UNIT PLAN

Unit 7
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Operation and Adjustment of Planting Devices: Grain Drill, Corn Planter, Grass Land Drill**

AIM: To produce a basic concept, in the student, of the operating principles of grain drills, corn planters and grass land drills.

INSTRUCTIONAL AIDS:

Charts, graphs, diagrams of grain drills, corn planters and grass land drills. May be secured from local farm machine dealer or send to one of the major-line agricultural machine manufacturers listed under Supplemental References and Resource Material.

EQUIPMENT:

Grain drill, corn planter, grassland drill, instruction manuals included and service manuals included.

PRIMARY REFERENCES:

1) Phipps, L. J. et al., **Farm Mechanics Text Handbook.** Danville, Ill.: The Interstate Printers & Publishers.

2) Smith, Harris P., **Farm Machinery & Equipment,** New York: McGraw-Hill Book Company, 1964.

3) Stone, A . A. and Gulvin, H. E., **Machines for Power Farming,** New York: John Wiley & Sons, Inc., 1967.

I. INTRODUCTION and MOTIVATION

A. Show charts and give background information on operation of drills and planters. In lab, show operating principles of machines.

B. A seed will not germinate unless it is covered to the correct depth with soil and the soil is in contact with the seed coat. Drills and planters do this job quickly and accurately.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Planting machines . . . general overview.	1. Identifying planting machines. 2. Analyzing the operation of planting machine. 3. Working capacities. 4. Efficiency. 5. Capabilities and liminations.	1. Timing gears. 2. Chain drive sprockets. 3. Speed and gear ratios. a. Used to improve speed b. Used to improve force
B. The grain drill.	1. Identifying parts. 2. Maintenance. 3. Lubrication. 4. Adjustment, shovels, drops. 5. Timing and setting seeding rate. 6. Fertilizer rate adjustment. 7. Storing the grain drill.	1. Study timing devices with chains and gears. 2. Mechanical advantage. 3. Levers. 4. Wheel and axle.
C. The corn planter.	1. Identifying parts. 2. Maintenance. 3. Lubrication. 4. Adjustment of seed plate, seed drops, furrow openers. 5. Selection of seed plates. 6. Timing and setting seeding rate. 7. Adjusting chain tensions. 8. Fertilizer rate adjustment. 9. Storing the corn planter.	1. Study seed plate furrow openers and drop design. 2. Study fertilizer placement in relation of seed placement. 3. Plant corn grain and study germination sequences. 4. Relate growth patterns to seed placement. 5. Proper conditions for seed germination and growth. 6. Conditions detrimental to growth of seeds.
D. The grass land drill.	1. Identifying parts. 2. Maintenance. 3. Lubrication. 4. Adjusting disc openers and covering chains. 5. Timing and setting seed rate. 6. Fertilizer rate adjustment. 7. Storing the grass land drill.	1. Study gear design to determine how seed rate remains constant at all speeds of planting.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Rate of planting. 2. Estimating amount of seed needed per acre. 3. Weight of seed per bushel.	1. Reading operator manual service charts, seeding rate tables.	1. Contrast planting capabilities of hand seeding and machine seeding. 2. Increased production produces more income thus changes economic status. 3. Discuss the impact on the standard of living of nations having a high degree of agricultural production.
1. Rate of planting. 2. Weight of seed per bushel. 3. Cost of seed per acre.		1. Study the effect of grain drills on the agriculture of the Great Plains area of U.S.A.
1. Rate of planting. 2. Cost of seed per acre. 3. Rate of fertilization per acre. 4. Cost of fertilizer. 5. Weight of seed per bushel.	1. Read operator's manual, service charts, seeding rate tables, and fertilizing rate tables.	1. Study the effect of corn planters on the agriculture of the Central Corn Belt of U.S.A.
1. Rate of planting. 2. Cost of seed per acre. 3. Weight of seed per bushel.		1. Study the effect of grass land drills on the agriculture of the High Plains area of U.S.A.

III. APPLICATION

A. Students will identify and study operation of three basic grain planting farm machines. The emphasis will be placed on the machine's relation to the crop to be planted. Basic operating techniques, adjustment and maintenance will be covered, but because of time limitation, student field operation of machine cannot be included.

IV. EVALUATION CRITERIA GUIDELINE

A. Why are planting rates, timing and speed so important in grain planting?

B. Why is fertilizer placed away from seed both in machine and in the soil?

C. Why is careful storage of planting devices necessary?

D. How are grain planting machines designed for the seed they are to plant?

V. SUMMARY

A. With correct operation and careful maintenance, planting devices have a long potential use life; lubrication and adjustment of chain drives, furrow openers and metering plates greatly enhance their future usefulness. Storage during non-use periods in protected sheds, barns, etc. is necessary for this type of equipment.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Introduction.

200 minutes . . . Laboratory.

40 minutes . . . Math.

40 minutes . . . Science.

20 minutes . . . Related concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Local County Agent.

2) Navarra, John G., **Today's Basic Science.** New York: Harper & Row Publishers, Inc., 1965.

3) United States Department of Agriculture, Washington, D. C.

4) **See listing on page T-VI-1.5**

INSTRUCTOR'S UNIT PLAN

Unit 8
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Operation, calibration and adjustment of Farm Sprayers**

AIM: To produce in the student a basic concept as to the use and application of spray devices for the protection of crops.

INSTRUCTIONAL AIDS:

Charts and graphs of sprayers and dusters obtained from local farm machine dealer.

EQUIPMENT:

PTO driven pump sprayer with boom, hand dusting gun and fan driven orchard sprayer.

PRIMARY REFERENCES:

1) **Ace Pumps**, Ace Pump Corporation, Memphis, Tenn.

2) **Agricultural Spray Nozzle Manual**, Spraying Systems Company, Bellwood, Ill.

3) **Chemical Applicators**, Gandy Company, Owatonna, Minn.

4) **Delavan Agricultural Spray Equipment**, Delavan Manufacturing Company, West Des Moines, Iowa.

5) Smith, Harris P., **Farm Machinery & Equipment**, New York: McGraw-Hill Book Company, 1964.

I. INTRODUCTION and MOTIVATION

A. Show charts and visual aids of sprayers. Explain the values and dangers of spray. In the lab, study operation principles of sprayers and dusters. Make sample mix and calibrate sprayer. Show operation of sprayer.

II. PRESENTATION OF INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Theory and principles of spraying	1. Effect of speed and pressure on amount applied. 2. Nozzles and nozzle size for proper coverage. 3. Adjustment of booms and chains for proper coverage. 4. Droplet size . . . effect of pressure and wind drift.	1. Nozzle size related to rate of application. 2. Viscosity and speed of flow. 3. Pressure. 4. Liquid flow.
B. Spray Equipment	1. Types. 2. Operational principles. 3. Parts and construction.	1. Pumps and liquid delivery processes. 2. Wind velocity.
C. Precautions and safety	1. Respirators (inhalation). 2. Protective suits (skin contact). 3. Warning signs of toxic activity on operator.	1. Spray drift due to wind. 2. Action of sprays on human.
D. Dust and dusting equipment	1. Effect of speed and pressure on amount applied. 2. Nozzles and nozzle size for coverage. 3. Principles of dusting.	1. Residual effect of dust. 2. Delivery systems for dusts.
E. Dusting equipment	1. Types. 2. Parts and construction. 3. Operational principles.	1. Wind velocity.
F. Theory and principles of fumigation equipment	1. Speed and pressure related to coverage. 2. Nozzles and nozzle size for coverage. 3. Droplet size; wind drift.	1. Effect of fumigants on soil organisms. 2. Residual effect of fumigation.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measure quantity of liquid. 2. Ratio of spray. 3. Material to dilutant. 4. Parts per 100. 5. Parts per 1000. 6. Dilution tables. 7. P.P.M.	1. Reading mixing instructions. 2. Understanding safety precautions.	1. Discuss impilcations of air and water pollution upon our civilization. 2. Construct a chart contrasting the economic value of spraying with ecological problems. 3. Discuss man's dependence on spray today contrasted with past.
1. Figure gallonage by using nozzle size and speed. a. Spray or nozzle pattern b. Nozzle angles c. Diagram cover pattern	1. Understanding charts and measuring devices for spray and dust mixtures. (Read and understand compatability charts.	
1. Cost of safety equipment. 2. Cost of spray and dust materials. a. Compute for per acre and per crop	1. Discuss danger of spraying and safety precautions.	
1. Figure coverage by using nozzle size and speed (see above).	1. Reading mixing instructions.	
1. Correlate reduced crop yield to cost of insect and weed control. a. Prepare a budget for one crop	1. Understanding charts and coverage data sheets.	
1. Figure cost of fumigation in greenhouse situation.	1. Reading mixing instructions. 2. Understanding safety precautions.	

III. APPLICATION

A. Have students read instructions and mix batch of spray.

B. Students put spray mix in sprayer and then calibrate sprayer.

C. Students check for coverage.

D. Students discuss value of spraying (pro and con).

IV. EVALUATION CRITERIA GUIDELINE

A. Why is crop spraying practiced to such a great extent by today's farmer?

B. What are the dangers of spraying?

C. What are the costs of spraying?

D. What is the difference between dusts and sprays?

V. SUMMARY

A. Spraying equipment is used to a great extent by today's farmer. Sprays are easy to use, effective in their job and can be applied quickly at low cost. Spray equipment is comparatively economical to buy and operate. Of great concern today are the problems of upsetting the balance of nature that large spraying operations can produce.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Introduction.

240 minutes . . . Lab and field operation.

40 minutes . . . Related concepts.

40 minutes . . . Evaluation and proficiency demonstration.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Farm Chemicals Handbook**, Master Publishing Co., Willoughby, Ohio.

2) Metcalf, R. L., **Destructive and Useful Insects**, New York: McGraw-Hill Book Company.

3) **See listing on page T-VI-1.5**

INSTRUCTOR'S UNIT PLAN

Unit 9
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Harvesting Equipment . . . Grain Combines, Forage Harvesters, Mowers, Hay Conditioners, Windrowers**

AIM: To provide a basic knowledge of the operation and use of crop harvesting farm machinery and to develop skills in operating this machinery.

INSTRUCTIONAL AIDS:

Film - **The Business of Gleaning,** Milwaukee, Wis. 53201: Allis-Chalmers Manufacturing Company, Photographic Group.
Charts of combines, forage harvester, mowers, hay conditioners, windrowers. (Get from local dealer or list of major-line agricultural machine manufacturers in Supplemental References.)

EQUIPMENT:

16mm film projector, screen, charts, blackboards, and **if possible:** Machines from local dealers; grain combine, mower, hay conditioner and forage harvester.

PRIMARY REFERENCES:

1) Cook, Glen C. et al., **Farm Mechanics Text and Handbook.** Danville, Ill.: Interstate Printers & Publishers, Inc., 1959.

2) Smith, Harris P., **Farm Machinery and Equipment,** New York: McGraw-Hill Book Company, 1964.

3) Stone, A. A. and Gulvin, H. E., **Machines for Power Farming,** New York: John Wiley & Sons, Inc., 1967.

I. INTRODUCTION and MOTIVATION

A. Show film: **The Business of Gleaning.**

B. The business of farming only pays off when the crop is in. Modern harvesting devices do this job quickly and efficiently. Explain to students each machine is engineered to the dimensions and growth characteristics of the crop it is to be used on.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Harvesting machines general overview	1. Working capacities. 2. Efficiency. 3. Capabilities and limitations. 4. Identifying farm harvesting machines and component parts. 5. Analyzing the operation of harvesting machines. 6. Horsepower requirements of harvesting machines.	1. Study pulley and belt speeds. 2. Study speed and gear ratios. 3. Study belt horsepower requirements.
B. The grain combine	1. Operating requirements. 2. Lubrication. 3. Maintenance. 4. Speed and operating capicity. 5. Adjustment. 6. Identifying parts. 7. Storage.	1. Study timing devices with gears, belts, governors. 2. Mechanical advantage with inclined planes and levers.
C. The forage harvester	1. Operating requirements. 2. Lubrication. 3. Maintenance. 4. Speed and operating capacity. 5. Adjustment. 6. Identifying parts. 7. Storage.	1. Study suction, vacuum, pressure, augers, screws.
D. Mowers	1. Operating requirements. 2. Lubrication. 3. Sharpening knives. 4. Replacing knives. 5. Adjusting sickle bar. 6. Adjusting wear plate. 7. Maintenance. 8. Identifying parts. 9. Storage.	1. Study cams reciprocating action (sickle bar).
E. Hay conditioners and windrowers	1. Operating requirements. 2. Lubrication. 3. Adjustments. 4. Maintenance. 5. Identifying parts. 6. Storage.	1. Study evaporation of moisture from crops. a. Effect of temperature b. Effect of humidity 2. Storage of crops moisture and fermentation bacterial action (good and bad) on crop storage.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Study storage bin capacities. 2. Crop yield in product per acre. 3. Study area of fields.	1. Read operator's manual and service charts for harvesting machines.	1. Study change in farm harvesting methods for today and yesterday.
1. Capacities of cylinders 2. Capacities of cubes. 3. Figuring area (acres).	1. Read operator's manual and service charts for grain combines.	1. Study economic backgrounds of countries that harvest grain by hand and machine. Construct a graph depicting the differential in grain tonnage produced by these countries.
1. Study yield of product per acre.	1. Read operator's manual and service charts for forage harvesters.	1. Study economic background of countries that raise a great deal of food for livestock. Compare maps of the Corn belt and Hog belt and make inferences. Extend this concept to countries.
1. Study dimensions of baled hay and relate to cubic area of hay mow. 2. Different storage areas for loose hay and baled hay.	1. Read operator's manual and service charts for mowers.	1. Study economic background of countries that raise a great deal of food for livestock. Compare maps of the Corn belt and Hog belt and make inferences. Extend this concept to countries.
1. Study operating cost, depreciation, and [illegible] farm machinery to be used (especially low-use machines such as hay conditioners).	1. Read operator's manual and service charts for hay conditioners and windrowers.	1. Study economic background of countries that raise a great deal of food for livestock. Compare maps of the Corn belt and Hog belt and make inferences. Extend this concept to countries.

III. APPLICATION

A. Students will study parts and identification of five basic grain and grass harvesting machines. Emphasis will be placed on the machine's relation to the crop to be harvested. Basic operating techniques, adjustments and maintenance will be covered; but because of time limitation, student field operation of machine cannot be included.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the criteria for an efficient harvesting machine?

B. How do harvesting machines depend on crop condition and growth characteristics?

C. Why are crop harvesting machines often more costly to own from an economic standpoint, than everyday use machines such as tractors?

D. Are harvesting machines more dangerous to operate than other farm machines?

E. Why are harvesting machines found in industrially-advanced countries?

V. SUMMARY

A. The use of harvesting machines greatly increases the productivity of an individual farmer. Only high income, industrilized countries can afford to operate this type of low use, high cost machine. With correct operation and careful maintenance, these machines have a long potential use life.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Introduction and film.

200 minutes . . . Laboratory.

40 minutes . . . Math.

40 minutes . . . Science.

20 minutes . . . Related concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Hay Conditioners,** Bulletin No. 339, Ithaca, N. Y.: Cornell University, 1961.

2) **Hay Conditioners in the Northeastern U. S.,** Bulletin No. 449, Ithaca, N. Y.: Cornell University, 1960.

3) **The Self-Propelled Windrower,** Bulletin No. 358, Ithaca, N. Y.: Cornell University, 1964.

4) Local County Agent . . . has bulletins on farm machine operation for local conditions.

5) United States Department of Agriculture, Washington, D. C. . . . has bulletins for national scale machine use.

6) **See listing on page T-VI-1.5**

INSTRUCTOR'S UNIT PLAN

Unit 10
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Selection and Purchase of Farm Machinery**

AIM: To produce an insight, in the student, into the selection of farm machinery for the type of farm operation to be engaged in.
To determine economic value and use capability for the farm operation.

INSTRUCTIONAL AIDS:

Film - **Men, Ideas and Tractors,** St. Louis, Missouri 63166: Swank Motion Pictures, Inc., 201 South Jefferson Ave.

EQUIPMENT:

16 mm projector, screen, used tractor with many mechanical defects, new tractor with no mechanical defects, used farm machine unit (baler, plow, etc.) and new farm machine unit (baler, plow, etc.).

PRIMARY REFERENCES:

1) Cook, Glen C. et al., **Farm Mechanics Text and Handbook,** Danville, Ill.: Interstate Printers & Publishers, Inc., 1959.

3) **Implement and Tractor Service Manuals,** Kansas City, Mo.: Implement and Tractor Publications, Inc., Current Edition.

3) **Implement and Service Manuals,** Kansas City, Mo.: Implement and Tractor Publications, Inc., Current Edition.

I. INTRODUCTION and MOTIVATION

A. Show film: **Men, Ideas and Tractors.**

B. Discuss methods of selecting farm machinery to do specific jobs.

C. Discuss economic aspects of selecting new or used machinery to do the job.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Selecting new farm machines	1. Machine work capacity. 2. Machine quality. 3. Machine suitability for the job. 4. Machine life capacity. 5. Machine warrantee and dealer responsibility. 6. Machine cost. 7. Parts and service availability.	1. Horsepower determination. 2. Engine efficiency (tractor). 3. Power requirements (implements). 4. Strength of materials in construction.
B. Selecting used farm machines	1. Operation hours on machine. 2. Age of machine. 3. Cost of machine. 4. Availability of repair parts. 5. Appearance of machine. 6. History of machine (if available).	1. How does efficiency relate to worn machine parts? 2. Friction, lubrication, wear correlation.
C. Farm machine selection criteria	1. Condition of painted surfaces. 2. Condition of tires, belts and wear plates. 3. Cost of new vs. old machine.	1. How does weather and use affect paint, rubber, steel?
D. Farm machine selection techniques	1. Operate motor. 2. Look for leaks, vibrations. 3. Listen for noises, abnormal or unusual. 4. Check for unusual temperatures (high or low). 5. Check alignments, belts, frames, etc. 6. Put the machine to the job.	1. How does vibration reduce operating efficiency? 2. Why does lubrication fail with too little and too much clearance? 3. Temperature and engine efficiency.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Cost of machine. 2. Depreciation of new machines. 3. Keeping cost and operating records.	1. Reading information booklets describing new machinery comparing data for various makes.	1. Study the rise in the use of farm machines in modern agriculture. 2. Construct graphs which illustrate the relationship of machine usage to agriculture production. a. Per worker output b. Research cost of food per family in terms of hours of labor necessary
1. Estimating cost for machine repair. 2. Calculating cost per operational hour.	1. Reading repair manuals and operator's manual for repair purposes. 2. Reading specification charts.	1. Determine how sales of used machines are correlated to economic conditions. 2. Identify regions where the purchase of used machinery is most prevalent. Search for a commonality of conditions among these regions.
1. Estimate value of repairs done to machine.		
1. Estimate cost of labor to repair deficiencies.		

III. APPLICATION

A. Students observe and use tests to discover defects in used machines.

B. Students compare operation of new vs. old machine. (Efficiency and time requirements per acre costs.)

C. Students estimate cost (time and materials) to repair used machines.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the average life of farm machinery?

B. What techniques are used to judge operating efficiency of a farm machine unit?

C. Why is availability of parts important to the buyer of used machinery?

D. How does the experienced farm machine operator save money with a good used machine?

E. How can breakdowns be reduced when using used farm machines?

V. SUMMARY

A. The cost of crop production is two-thirds related to machine and labor costs. By careful selection of farm machinery, the machine costs can be kept to a minimum. Selection and purchase of this machinery is a very important aspect of this cost of production. Training the machine operator is of the greatest importance in this field.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Film and introduction.

240 minutes . . . Laboratory.

40 minutes . . . Science.

20 minutes . . . Related concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Brown, A. D. and Morrison, I. G., **Farm Tractor Maintenance,** Danville, Ill.: Interstate Printers & Publishers, Inc., 1962.

2) **Farm Tractor Tune-Up and Service Guide,** Athens, Georgia 30601: American Association for Vocational Instructional Materials, Engineering Center.

3) **Gulf Farm Tractor Guide,** Houston, Texas: Gulf Oil Company, Marketing Technical Division.

4) O'Brien, M., **Demonstrations for Farm Mechanics,** Danville, Ill.: Interstate Printers & Publishers, Inc., 1957.

5) Pamphlets and brochures from local farm machine dealers.

6) **The Operation, Care and Repair of Farm Machinery,** Moline, Ill.: Deere and Company, 1957, 28th Edition.

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INSTRUCTOR'S UNIT PLAN

Unit 11
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Diesel Engine Theory and Operation**

AIM: To be able to describe the theory and operation of two and four-cycle diesel engines which are generally found in earthmoving vehicles.

INSTRUCTIONAL AIDS:

Flip Charts - **Diesel Engine Theory and operation.** Detroit: General Motors Corporation, Detroit Diesel Engine Division.

Film - **ABC of Diesel Engines.** Detroit: General Motors Corporation, Public Relations Staff, Film Library, General Motors Building.

Transparency - **T-13-1 GM Two-Stroke Diesel Engine.** Philadelphia: DCA Educational Products, Inc., 4865 Stenton Avenue.

EQUIPMENT:

16mm projector, screen and overhead projector.

PRIMARY REFERENCES:

1) **Diesel Engine Maintenance Manual - - In-Line Diesel Engine Series 71.** Pontiac, Michigan: General Motors Corporation.

2) **Diesel - - The Modern Power.** Detroit: General Motors, Public Relations Staff, General Motors Corporation.

3) **Series 53 - - Engines - - Detroit Diesel Maintenance.** Detroit: General Motors Corporation, Detroit Diesel Engine Division, General Motors Corp.

4) Duffy, J. W., **Power - - Prime Mover of Technology.** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1964.

I. INTRODUCTION and MOTIVATION

A. Introduce and show film: **ABC of Diesel Engine.** Discuss the use of diesel engines in heavy equipment and point out the importance of the knowledge of the operation of the diesel engine as it relates to the overall operation of heavy equipment.

II PRESENTATION of INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. The theory and operation of four-stroke cycle diesel engines.	1. Four-stroke cycle. a. Intake stroke b. Compression stroke c. Power stroke d. Exhaust stroke 2. Fundamental differences between diesel and gasoline engines. a. In the diesel, fuel and air are mixed inside the cylinder b. Ignition in diesel engines is accomplished by heat of compression 3. High compression ratios. a. 17:1 ratio b. Heat of compression necessary for ignition 4. Fuel systems: a. Unit injector b. Common rail c. Multiple pump d. Distributor fuel system e. Octane rating 5. Starting systems: a. Pneumatic b. Hydraulic c. Electrical 6. Governors and their relation to load and speed. 7. Intake and exhaust valves.	1. Methods for determining compression ratios. 2. Relations between high compression ratios and efficiency. 3. Relation between molecular activity and heat. 4. Principle of Pascal's law. 5. Atomization. 6. Octane rating. 7. Relation between power and amount of fuel sprayed in cylinder.
B. The theory and operation of two-stroke cycle diesel engines.	1. Two-stroke cycle. a. Intake and power stroke b. Exhaust and compression stroke 2. Two-stroke cycle delivers power once per revolution of crankshaft; four-stroke cycle delivers power once every other revolution of the crankshaft. 3. Major difference in design between four-cycle diesel and two-cycle diesel is in valving arrangements. a. Exhaust valves b. Roots blower and scavenging effect takes place of intake valves	1. Scavenging effect. 2. Principles of operation of an air pump or blower (roots).

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Computing compression ratios. 2. Computing the area of a circle.	1. Reading and interperting gauges. 2. Recording gauge readings. 3. Development of nomenclature and vocabulary. a. Scavenging b. Blower c. Fuel timing d. Injectors e. Compression ignition f. Molecular activity g. Vacuum at manifold h. Octane rating i. Strokes j. Cycles	1. Efficiency of diesel engines and their effect upon conserving fossil fuels. 2. Diesel engine exhaust pollutants.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
	4. Air forced across top of piston unidirectionally removes exhausted gas and provides fresh charge of air for compression and power. 5. Ignition of two-cycle takes place in similar manner to four-cycle.	
C. Operation of four and two-cycle diesel engines.	1. Starting procedures. a. Check fuel level and filter system before starting b. Check water level c. Check oil level d. Check condition of air filters e. Run at low RPM's until operating temperature has been reached f. Check instrument panel for gauge readings 2. Stopping procedures. a. Pull lack of fuel shut-off lever b. Emergency shut-off procedures	1. Interpretation of instrument panel gauges. 2. Principles of engine cooling.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

A. Each student should identify and explain the operation of the major components of a diesel engine.

B. Each student should gain experience in the procedures for starting and stopping a diesel engine.

C. Each student should record and interpret the instrument panel gauges.

IV. EVALUATION CRITERIA GUIDELINE

A. Describe the difference between a two-cycle and four-cycle diesel engine.

B. What is the purpose of the emergency shut-off?

C. Compare the major differences between a spark ignition and compression ignition engine.

D. List three major types of fuel systems associated with diesel engines.

E. What is the rating system for diesel fuel?

V. SUMMARY

A. The basic knowledge of diesel engine operation is necessary in order to fully understand the maximum working potential of a piece of heavy equipment.

B. Good heavy equipment operators need to know more than just the operation of a particular piece of equipment.

C. Review the steps for starting and stopping a diesel engine.

VI. SUGGESTED TIME and SEQUENCE LISTING

60 minutes . . . Introduction and showing of film: **ABC of Diesel Engine.**

100 minutes . . . Laboratory experience.

180 minutes . . . Integrated curriculum concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **A Power Premier,** Detroit: General Motors, 1955 (pamphlet).

2) Armstrong, Lloyd V. and Hartman, James B., **Diesel Engine,** New York: Macmillan Company, 1960.

3) Purday, H. F. P., **Diesel Engine Designing,** Princeton, N. J.: D. Van Nostrand Company, Inc., 1963.

INSTRUCTOR'S UNIT PLAN

Unit 12
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Diesel Engine Tune-Up**

AIM: To be able to successfully complete a minor diesel engine tune-up.

INSTRUCTIONAL AIDS:

Wall and flip charts from Detroit Diesel Corporation, Detroit, Michigan.

EQUIPMENT:

Detroit diesel two-cycle engine (preferably a 3-53).
Appropriate special tools and gauges for tune-up (available from Kent-Moore Inc., Warren, Michigan).

PRIMARY REFERENCES:

1) **Series 53 Engine, Detroit Diesel Maintenance,** Detroit: General Motors Corporation, Detroit Diesel Engine Division.

2) Maintenance Manual appropriate to engine being serviced.

I. INTRODUCTION and MOTIVATION

A. Explain the reasons why an untuned engine is inefficient and briefly compare the tune-up procedures between a diesel engine and a gasoline engine.

B. Call attention to the environmental effects an untuned engine has on the earth's atmosphere.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Engine tune-up procedures.	1. There is no scheduled interval for performing an engine tune-up As long as the engine is performing satisfactorily, no tune-up is needed. 2. Minor adjustments to compensate for valve and injector wear should only be performed periodically.	
B. Tune-up safety procedures.	1. The diesel engine is compression-ignition engine and will start whenever the starter is operated and fuel is supplied to the injectors. 2. For some adjustments the engine will have to be rotated by "tapping" the starter. When performing this operation, make sure the injector rack is manually held in the no fuel position and the emergency stop is closed. 3. Remove key from switch when making all adjustments.	
C. Recommended tune-up procedures.	1. Adjust exhaust valve clearance. 2. Adjust fuel injector timing. 3. Fuel control rack adjustment. 4. Adjust buffer screw.	
D. Adjusting exhaust valve clearance.	1. The correct exhaust valve clearance at normal engine operating temperature is important for smooth, efficient operation of the engine. a. Remove valve cover b. Place speed control lever in the idle speed position c. Rotate crankshaft until injector follower is fully depressed d. Loosen push rod lock nut e. Place appropriate feeler gauge between valve stem and rocker arm and adjust push rod to desired specifications f. Tighten lock-nut g. Recheck adjustment	1. The principles of the expansion and contraction of metals.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
	1. Reading tune-up manuals and interpreting specifications.	1. The effects an untuned engine has on polluting the atmosphere.
1. Concept of decimal fractions.		
1. Computations in one thousandth of an inch.		

II. PRESENTATION of INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
E. Adjusting fuel injector timing.	1. The correct fuel injector timing is needed so that the fuel is injected into the cylinder under varying load and speed conditions. a. Remove valve cover b. Place speed control lever in the idle speed position c. Rotate crankshaft until tthe exhaust valves are fully depressed on a particular cylinder d. Install injector timing gauge in the hole provided in the top of the injector body, with the flat of the gauge toward the injector follower e. Loosen the push rod nut f. Adjust push rod to specifications g. Tighten lock nut h. Recheck adjustment	1. The relationship between load, horsepower, and engine spin. 2. Atomization.
F. Fuel control rack adjustments.	1. The fuel control rack must be adjusted so that each one of the injectors will emit the same quantity of fuel to insure equal distribution of load. a. Loosen lock rod and lockout buffer adjusting screw b. Loosen inner and outer adjusting screws of all injector rack control levers several turns c. Move governor control lever into full fuel position and hold by hand d. Turn down inner adjusting screw at No. 1 injector rack control lever until governor control lever starts to move away from full fuel position e. Tighten outer adjusting screw to lock rack control lever in position f. Adjust the remaining control levers in the same manner as dscribed above	1. The relationship between quantity of fuel, load, and power developed. developed.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
G. Adjust buffer screw.	1. Governors are equipped with buffer springs, the purpose is to prevent low speed engine "roll" or "stalling," which is characteristic on some engines, but not all. 2. To adjust, turn the buffer screw in until engine idling speed is increased slightly, but not in excess of 20 spins, thus insuring spring contact with the differential lever.	1. The use of governors to control engine spin under varying load requirements.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

A. Demonstrate to students the correct procedure for tuning up a diesel engine.

B. Assign students to groups of 2 or 4 and have each group tune-up a diesel engine.

IV. EVALUATION CRITERIA GUIDELINE

A. When is it necessary to service or tune a diesel engine?

B. Explain why a diesel engine needs t[illegible]ed.

C. What similarities are there between tuning a diesel and gasoline engine?

D. Why is a governor used on a diesel engine?

V. SUMMARY

A. Most of the heavy earthmoving equipment used today has a diesel engine as its prime power source. In order to get maximum output from the power source it is necessary that it be tuned. An untuned engine cannot produce as much work as a tuned engine.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Introduction and motivation.

60 minutes . . . Instructor demonstration of tune-up procedures.

200 minutes . . . Students laboratory experiences.

60 minutes . . . Related study in science, math, communications and social studies.

20 minutes . . . Summary and discussion of tune-up procedures.

VII. SUPPLEMENTAL REFERENCES and RESOURCE M[illegible]ERIAL

1) Maintenance manuals for other dies[illegible] engines.

INSTRUCTOR'S UNIT PLAN

Unit 13
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Front End Loader**

AIM: To understand the basic operating procedures of the front end loader.

INSTRUCTIONAL AIDS:

Wall charts, hand-outs and transparencies illustrating the nomenclature and application of front end loaders.

EQUIPMENT:

Caterpillar front end loader and/or transportation to site of front end loader.

PRIMARY REFERENCES:

1) **Operation and Maintenance Instructions for Caterpillar Front End Loader,** Caterpillar Tractor, Inc., 1968.

I. INTRODUCTION and MOTIVATION

A. Identify the basic nomenclature of the front end loader and demonstrate to the class its operation in moving earth.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Safety precautions.	1. The following are safety precautions to follow when operating the front end loader. a. Do not leave machine unattended b. Never leave machine with bucket in the air c. Watch bucket and directions at all times d. Avoid greasy hands and floors e. Never get on or off a machine in motion f. Stop machine to lubricate or adjust g. Never lift bucket over ground crew h. Keep brakes properly adjusted i. Never transport load with bucket fully raised j. Always set brake when machine is parked k. Maintain proper tire inflation l. Select proper speed range m. Do not use bucket as brake n. Check before moving loader o. Do not operate machine without instructions	1. Review of basic law of hydraulics and pnuematics.
B. Normal starting procedures.	1. Pre-starting checks. a. Engine oil level b. Engine air cleaner c. Hydraulic system oil level d. Cooling system e. Fuel supply f. Transmission level g. Tire pressure 2. Warm-up checks. a. Engine oil pressure gauges b. Ammeter c. Air pressure brakes gauge d. Engine temperature e. Torque converter temperature gauge f. Horn g. Lights h. Hydraulic system boom and bucket control levers i. Visual inspection for possible leakage	1. Development of condensation in fuel tank. 2. Principles of convection of conduction. 3. Friction.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Development of formulas to determine braking distances under certain load and speed conditions.	1. Sounding the horn. 2. Knowledge of hand signals.	
		1. The use of earthmoving equipment and its effects upon the transportation network in contemporary society. 2. The effect of exhaust emissions on the earth's atmosphere. 3. The development of unions. 4. Noise control.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
C. Shutting down engine.	1. Idle engine 3 to 5 minutes before shutting down. 2. Turn ignition switch off. 3. Bleed air brake reservoir.	
D. Operation of tractor shovel.	1. Loading the bucket. a. Low range speed, directional lever in forward, and range shift lever in working range b. Adjust bucket until level with ground c. Move bucket stockpile with cutting edge parallel to the ground and push cutting edge into pile until bucket is nearly full d. Raise bucket with boom control lever e. Tip bucket against stops as bucket is being raised f. Continue to raise bucket until out of pile g. Back out of pile and deliver to desired dumping position 2. Transport load as appropriate to field conditions. 3. Dumping the bucket. a. Approach load site until bucket clears top edge b. Place boom lever in hold position when proper height is obtained c. Position front end loader perpendicular to dump site d. Apply service brakes to disengage transmission and supply maximum hydraulic power to bucket cylinders e. Dump bucket f. Close and back away from site and recycle operation	1. Principles of closed system hydraulics. 2. Multiplication of forces. 3. Basic principles of kinetics and kinematics. 4. Force equals mass x acceleration. (Relationship of moving frontend loader to stockpile.)

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
	4. Backfilling and spreading. a. Place bucket cutting edge parallel to ground surface and move ahead at slow speed range b. Best results obtained when shallow bite is taken c. The above procedure may be used to spread material, strip level, or backfill ditches and foundations	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

A. Have each student identify the major components of a front end loader, with special emphasis on safety.

B. Each student should demonstrate the correct procedure for starting and stopping the front end loader's power plant.

C. Each student should demonstrate his ability to transport earth from one site to another.

IV. EVALUATION CRITERIA GUIDELINE

A. Why is it important to warm up the front end loader's power plant?

B. How is the capacity of the bucket measured?

C. Identify five hand signals commonly used in the operation of the front end loader.

D. What is the position of the bucket during backfilling and spreading?

E. What is the relationship between mass and acceleration?

V. SUMMARY

A. Review the basic operating procedures of the front end loader with attention directed to relevant safety aspects of its operation.

B. Summarize the basic uses of the front end loader including spreading, backfilling and transporting earth.

VI. SUGGESTED TIME and SEQUENCE LISTING

60 minutes . . . Introduction and demonstration.

180 minutes . . . Laboratory experience.

100 minutes . . . Integrated curriculum concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Operator's manuals from other companies producing front end loaders.

INSTRUCTOR'S UNIT PLAN

Unit 14
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Motor Grader**

AIM: To be able to identify the uses of a motor grader and describe its basic operating procedures.

INSTRUCTIONAL AIDS:

Wall charts, hand-outs and transparencies illustrating motor grader nomenclature and application.

EQUIPMENT:

Caterpillar motor grader and/or transportation to site of motor grader.

PRIMARY REFERENCES:

1) **Operation and Maintenance Instructions, Caterpillar Motor Grader,** Caterpillar Tractor Inc., 1968.

I. INTRODUCTION and MOTIVATION

A. Describe and demonstrate to the class the basic uses and operating procedures of the motor grader.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Safety precautions in the operation of the motor grader.	1. Review of safety practices developed in unit of front end loader which would be pertinent to the motor grader.	
B. Starting procedures for motor grader.	1. Review of starting procedures developed in unit on front end loader. a. Pre-starting checks b. Warm -up checks	
C. Procedures for shutting down motor grader.	1. Review of shutting down procedures developed in unit on front end loader.	
D. Operation of motor grader.	1. Driving the motor grader. a. Most motor graders have six speeds forward and two in reverse b. Two separate pedals are used for acceleration and deceleration c. Front wheel lean to counteract side thrust d. Hydraulic steering 2. Power controls. a. Blade lift adjusts heights of blade b. Side shift offset blade c. Circle reverse control to rotate blade 360° d. Power control on front wheel lean to aid in turning and counteracting side thrust in operation e. Scarifier control to adjust depth of scarifying 3. Blade pitch positions. a. Angle of blade in relationship to surface	1. Multiplication of force through the use of gears. 2. Front end geometry turning radius. 3. Multiplication of force through the use of closed hydraulic systems.
E. Application of the motor grader.	1. Spreading and leveling stone or gravel. 2. Scarifying to remove large rocks. 3. Cutting banks.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Calculating of force through use of hydraulic cylinders and pistons.	1. Voice and hand signals. 2. Nomenclature of motor grader.	1. The effects of highway construction on contemporary society. 2. The effects unions and wage rates have upon today's society.
1. Determining the angle of the blade for cutting a bank.		

III. APPLICATION

A. Have each student identify the major components of the motor grader including those related to the power plant, hydraulic and mechanical systems.

B. Have each student statically demonstrate the operating procedures for leveling with the motor grader.

IV. EVALUATION CRITERIA GUIDELINE

A. Describe three uses of the motor grader.

B. What is meant by the term blade pitch?

C. Why is it necessary to have six speeds forward and two in reverse in a motor grader?

D. How is side thrust counteracted?

V. SUMMARY

A. The motor grader is generally used in road construction to level, cut banks and scarify.

B. Summarize and review the basic operating procedures of the motor grader.

VI. SUGGESTED TIME and SEQUENCE LISTING

60 minutes . . . Introduction and demonstration of basic motor grader functions.

200 minutes . . . Laboratory experience.

80 minutes . . . Integrated curriculm concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Operator's manuals from different motor grader companies.

INSTRUCTOR'S UNIT PLAN

Unit 15
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **The Operation and application of the Bulldozer**

AIM: To be able to describe the operation and application of the bulldozer as it is related to the construction industry.

INSTRUCTIONAL AIDS:

Flip charts, wall charts, hand-outs and transparencies illustrating the operation and application of the bulldozer.

EQUIPMENT:

Bulldozer.
Transportation of class to job site where bulldozers are in operation.

PRIMARY REFERENCES:

1) **Operator's Guide to Bulldozers #FEO45080-02,** Caterpillar Tractor Inc., 1968.

2) **Operation and Maintenance Instructions, Bulldozer,** Caterpillar Tractor Inc., 1968.

I. INTRODUCTION and MOTIVATION

A. Illustrate with resource materials the basic moving parts of the bulldozer and its application in the construction industry.

B. Prepare student for field trip to observe the bulldozer in operation.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Pre-starting checks.	1. Crankcase oil level. 2. Engine coolant level. 3. Hydraulic system level. 4. Transmission oil level. 5. Fuel level. 6. Air cleaner indicator. 7. Starting engine oil level. 8. Starting engine fuel level. 9. Check controls for free movement.	1. The need and purpose of lubricants. 2. Octane fuel ratings.
B. Diesel engine starting.	1. Start the gasoline starting engine. 2. Start the diesel engine. 3. Shut off gasoline starting engine. 4. Allow diesel engine to reach operating temperature.	
C. Diesel engine running.	1. Check oil pressure. 2. Check water temperature. 3. Check amperes. 4. Check fuel pressure. 5. Check converter temperature.	1. Bourbon gauges.
D. Operation.	1. Throttle control. 2. Directional controls. 3. Brake controls. 4. Implement controls . . . front and rear.	1. Basic hydraulics.
E. Safety precautions.	1. Stay on seat. 2. Clean hitch pin. 3. Keep undercarriage free and clear of trash. 4. Avoid moving parts. 5. No riders. 6. Watch for buried cables. 7. Clean engine area. 8. Block implements to attach. 9. Do not smoke around fuel or oil.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Computations involving cubic feet of dirt moved per hour.	1. Hand signals.	1. The effects highways have had on our societies.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
F. Application of bulldozer.	1. Ditching. 2. Pioneering. 3. Backfilling. 4. Clearing trees. 5. Scarifying. 6. Pushing. 7. Leveling.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

A. Conduct field trip to construction site where bulldozer is in operation. Students should be made to identify the application of the bulldozer in its operation. Interview the operator for general information on how they feel about their job and role in the construction industry.

IV. EVALUATION CRITERIA GUIDELINE

A. Identify the following terms: scarifing, pioneering, trenching and leveling.

B. What purpose does the starting engine serve?

C. What controls the direction of the bulldozer?

D. What physical attributes should a bulldozer operator possess?

V. SUMMARY

A. The bulldozer is used in construction for a variety of jobs including pushing, clearing, leveling and many more. The operator of a bulldozer is a highly skilled individual, who by the nature of his job, is required to work outdoors in all types of weather.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Introduction and motivation.

20 minutes . . . Prepare class for field trip.

240 minutes . . . Field trip.

60 minutes . . . Related study in science, math, communications and social studies.

20 minutes . . . Summary and discussion.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Publicity or advertising literature from various equipment companies.

INSTRUCTOR'S UNIT PLAN

Unit 16
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Operation of a Backhoe**

AIM: To be able to describe the application and perform basic operations of a backhoe.

INSTRUCTIONAL AIDS:

Flip charts, wall charts and transparencies illustrating the application and basic operations of the backhoe.

EQUIPMENT:

Backhoe.

PRIMARY REFERENCES:

1) **Operation and Maintenance Instructions, Caterpillar Backhoe,** Caterpillar Tractor Inc., 1968.

2) Operating Manuals for other backhoes.

I. INTRODUCTION and MOTIVATION

A. Demonstrate the basic operating procedures of the backhoe and its application in the construction industry.

B. Conduct field trip to job site and have students observe the operation of the backhoe. Interview the operator to determine general information regarding the application and operation of the backhoe.

II. PRESENTATION of INTEGRATED CONCEPTS

	RELATED CONCEPTS	
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Basic machine.	1. Rotating joint. 2. Idler gears. 3. Drive gear. 4. Reduction shaft. 5. Horizontal swing shaft. 6. Vertical swing center drive shaft. 7. Hydraulic drive shaft. 8. Vertical swing shaft. 9. Reverse shaft. 10. Vertical travel shaft. 11. Vertical center drive shaft. 12. Conical rollers. 13. Idler roller. 14. Swing pinion. 15. Drive chain. 16. Swing brake. 17. Drive sproket. 18. Traction shaft.	1. Basic gear design laws of kinetics; torsion stresses, induced in shafts.
B. Basic machine. 1. Power.	1. Two-section hydraulic pump driven by machine's engines.	1. Pump design. 2. Hydraulic pressures developed by pumps.
C. Controls.	1. Disconnect clutch. 2. Steer levers. 3. Travel lever. 4. Travel button. 5. Swing lever. 6. Boom hoist lever. 7. High speed hoist button. 8. Swing lock lever. 9. Two-speed travel lever. 10. Swing brake control. 11. Bucket pedal. 12. Arm pedal.	1. Use of controls to activate sciences developed under sections A and B.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Develop formulas for gear ratios, calculations for revolutions per minute; calculate shaft stresses; develop formulas for braking power.	1. General knowledge and familiarity of terms used.	1. Development of the wheel by mankind to gears and advancement into complex equipment.
1. Develop formulas for calculations with pressures from pumps.	1. General knowledge and familiarty of terms used.	
	1. Basic hand signals used between the operator and other workers.	1. The advancement of our society due to machine design in construction.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
D. The instrument panel.	1. S.O.M. gauge. 2. Filter pressure gauge. 3. Hydraulic system temperature. 4. Engine temperature. 5. Engine oil pressure. 6. Ammeter. 7. Key. 8. Pilot light. 9. Hydraulic pressure light. 10. Lube pressure light. 11. Bulb test. 12. Engine shutdown. 13. Horn. 14. Emergency shutdown.	1. Development of units and quantities recorded on gauges. a. Hydraulics b. Electricity
E. Starting the machine.	1. Disengage master clutch. 2. Start the machine's engine. 3. Idle the machine until it reaches operating temperature. 4. With the engine running, engage master clutch. 5. Allow the engine to run slowly until the hydraulic system warms up. 6. Activate controls to work the machine.	1. Application of previously developed sciences.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Develop formulas for P.S.I., ampers, volts, etc.	1. Knowledge of units in which gauges are read and what they mean.	
1. Same as previously developed.		

III. APPLICATION

A. Demonstrate the operating procedures of the backhoe and perform basic applications such as trenching, digging, etc.

B. Conduct field trip to job site.

IV. EVALUATION CRITERIA GUIDELINE

A. What type of power source is used to operate the bucket?

B. Identify three hand signals which are used when operating the backhoe.

C. The hydraulic pump on the backhoe is driven by the .....

D. Describe three applications of the backhoe.

V. SUMMARY

A. The backhoe is an extremely versatile piece of equipment which can be used for a variety of jobs. The basic operation of this machine is relatively simple; however, much practice and experience is necessary before an operator gains proficiency in the use of the backhoe.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Prepare for field trip.

60 minutes . . . Field trip.

60 minutes . . . Teacher demonstration.

140 minutes . . . Student learning experiences.

60 minutes . . . Related study in science, math, communications and social studies.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit 17
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **Basic Applications of the Shovel**

AIM: To be able to describe basic applications of the shovel in the construction industry.

INSTRUCTIONAL AIDS:

Flip charts, wall charts and transparencies illustrating the basic operations and applications of the shovel.

EQUIPMENT:

Basic shovel.

PRIMARY REFERENCES:

1) **Operator's Manual for Basic Shovel. Link-Belt Speeder, Inc.,** Cedar Rapids, Iowa, 1971.

2) Operator's manuals for the basic shovel from a variety of sources.

I. INTRODUCTION and MOTIVATION

A. Discuss with students the basic operation and application of the shovel.

B. Prepare students for field trip so that they can recognize the application of the shovel on the job site.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEP

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Trenching (backhoe).	1. Pipe line installation. 2. Digging footings for building construction.	1. Under all topics, the proper size machine can be determined based on desired reach, weight of objects to be lifted, angle at which it is to be lifted, quantity of excavation desired, and the given time to accomplish the excavation. 2. Principles of levers
B. Quarrying (dipper stick).	1. Loading trucks at a sand or gravel pit. 2. Loading trucks on railroad cars at a strip mine.	
C. Crane (crane boom and clam shell bucket).	1. Steel erection. 2. Pouring concrete on building construction. 3. Excavation in close quarters with clamshell.	
D. Dragline (crane boom and dragline bucket).	1. Irrigation canals. 2. Cleaning river channels. 3. Strip mining.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Given various known factors previously listed, and knowing the various aspects of each machine, develop rules and formulas for determining the proper weight of machine, length of boom and size of bucket needed for each job.	1. Obtain a working knowledge of terms used in the utilization of the basic shovel for other types of work.	1. Show how the shovel has aided man in the building construction, highway construction, irrigation systems, and pipelines to his social and economic benefit.

III. APPLICATION

A. Conduct field trip to job site where the shovel is in use. Identify the major working parts of the shovel. Discuss the application of the shovel at the job site. Interview the operator of the shovel to obtain general knowledge of the shovel and the operator's reaction to his job.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the dipper stick used for?

B. Identify two applications of the dragline.

C. Identify two applications of the crane.

D. What supplies power to the clamshell bucket?

V. SUMMARY

A. The basic shovel is used in a variety of applications in the construction industry including quarrying, dragline operation and trenching. Although the shovel is not as versatile as other equipment, its application is none the less of prime importance to the construction industry.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Introduction and motivation.

30 minutes . . . Prepare for field trip.

140 minutes . . . Field trip.

140 minutes . . . Related study in math, communications and social studies.

30 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit 18
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **The Use of the Compressor in Construction**

AIM: To understand the basic principles and operation of air compressors and to be able to operate and service air compressors normally used in construction work.

INSTRUCTIONAL AIDS:

Film - **Overworked and Underpowered,** Cleveland, Ohio: Educational Committee, Compressed Air and Gas Institute (16 mm).

Film - **Compressed Air Power,** Cleveland, Ohio: Educational Committee, Compressed Air and Gas Institute (16 mm).

Film - **Compressed Air and Gas - - Yours to Command,** Cleveland, Ohio: Educational Committee, Compressed Air and Gas Institute (16 mm).

EQUIPMENT:

16 mm projector, screen and construction type air compressor.

PRIMARY REFERENCES:

1) Le Roi, **"600" Rotary Air Compressor Instruction Manual and Parts Test,** Sidney, Ohio: Wabco Le Roi Division, Westinghouse Air Brake Company.

2) Stewart, H. L. and Storer, J. M., **Fluid Power,** Indianapolis: Bobbs-Merrill Company, Inc., 1968.

I. INTRODUCTION and MOTIVATION

Show films and discuss the basic principles of operation of air compressors and their specific application as related to the construction industry.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Types of air compressors.	1. Reciprocating air compressors. 2. Rotary air compressors.	1. Boyle's law. 2. Charles' law.
B. Comparison between reciprocating and rotary air compressors.	1. Show why rotary compressors are better than reciprocating compressors. a. Compactness b. Lightweight. c. Uniform flow. d. Variable output. e. Carefree operation f. Long life	
C. Checks before starting the compressor.	1. Place unit level. 2. Drain condensate from air receiver. 3.Check and maintain the oil level in the air receiver and in engine crankcase. 4. Be sure that the radiator is filled. 5. Check the fan belt tension. 6. Fill the engine tank with gasoline or diesel fuel as appropriate.	
D. Starting the air compressor.	1. Open service valve. 2. Pull out choke control. 3. Push ignition switch to on and depress starter switch. 4. Adjust choke. 5. Adjust service valve to capacity pressure until engine warms up. 6. Check all instruments for proper operation.	
E. Stopping the air compressor.	1. Close service valve and allow unit to run unloaded until the engine cools. 2. Switch off the ignition switch. 3. Open service valve.	
F. Safety devices on compressors.	1. Dump valve. 2. Minimum pressure valve. 3. Oil relief valve.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Formulas for using Boyle's and Charles' laws.	1. Familiarize students with main parts and terminology used in the operation and maintenance of air compressors.	1. How the use of compressor air tools has improved man's capacity to work and produce with less effort.

III. APPLICATION

A. Students in groups of 2 or 4 should operate the air compressor as demonstrated by the instructor.

B. Students in groups of 2 or 4 should perform routine maintenance inspections and services as demonstrated by the instructor.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the difference between a rotary and piston air compressor?

B. Which of the above compressors is most frequently found in construction? Why?

C. What is the relationship between pressure and volume?

D. What measures must be taken before starting the compressor?

E. What function does the air compressor perform in terms of driving power tools?

V. SUMMARY

A. The air compressor is frequently used on construction sites as a source of power for power tools. The compressed air provided by the air compressor is used for such power tools as drills; grinders; jack hammers and many more.

B. Although the operation of the air compressor is simple, routine operation and maintenance procedures must be followed to obtain efficient operation.

VI. SUGGESTED TIME and SEQUENCE LISTING

10 minutes . . . Introduction and motivation.

60 minutes . . . Films.

60 minutes . . . Demonstration of air compressor.

100 minutes . . . Operation.

60 minutes . . . Student learning experiences.

50 minutes . . . Related study in science, math, communications and social studies.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Compressed Air Power in Construction.** Cleveland: Educational Committee, Compressed Air and Gas Institute (pamphlet).

2) Pease, Dudley A., **Basic Fluid Power.** Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1968.

INSTRUCTOR'S UNIT PLAN

Unit 19
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **The Use of the Level in Construction Layout**

AIM: To be able to identify the uses of the level in construction layout and lay out a simple elevation.

INSTRUCTIONAL AIDS:

Flip charts, handouts and transparencies illustrating the use of the level in construction layout.

EQUIPMENT:

Construction level and level rods.

PRIMARY REFERENCES:

1) Davis, Raymond E., Foote, Francis S. and Kelly, Joe W., **Surveying: Theory and Practice.** New York: McGraw-Hill Book Company, 1966.

2) Kissam, Philip, **Surveying Practice.** New York: McGraw-Hill Book Company, 1966.

I. INTRODUCTION and MOTIVATION

A. Describe and explain the need for the level in determining elevations and the relationship between this and the transit.

B. Prepare students for field trip.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. The telescope.	1. The objective lens. 2. The cross hairs. 3. The eyepiece. a. Inverted image b. Direct image	1. Science of optics, as previously developed in the transit.
B. The leveling screws and footplate.	1. The telescope must be level when used.	1. Descriptive geometry - - - the leveling screws and footplate will keep the telescope in the same plane as it rotates.
C. Setting up the level.	1. Attain approximate level by adjusting the legs. Complete the operation using the leveling screws.	
D. The level rods.	1. Self reading rods 2. Target rods. a. Philadelphia rod b. New York rod	1. The measured foot is divided into 100 equal parts.
E. Keeping field notes.	1. Bench mark. 2. Foresight. 3. Backsight. 4. Height of instrument. 5. Turning point.	1. U. S. Coast and geodetic survey relating all elevations to mean sea level at Sandy Hook, N. J. elevation 0.00.
F. Use of the level on construction sites.	1. Determining ground contours. 2. Setting elevations on grade stakes. 3. Determining earth quantities.	1. Developing contour maps. 2. Develop the use of grade sheets. 3. End area method. 4. Describe and define units of measurement: cubic feet, cubic yards, etc.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Computations for magnifying power. 2. Computations for field of view.	1. Proper signal to be used between the leveler and the rod man.	1. Same as previously developed for the transit.
1. Develop reading of the rod in proper decimal values: foot, tenths and hundredths.		1. The impact of measuring height differential on man through the design of safe highways, irrigation systems and the advent of contour maps.
1. Series of additions and subtractions.	1. Proper transfer of field information from the field to designers in a standard tabulated form.	1. Same as developed above.
1. Addition and subtraction. 2. Develop formula for end area method.	1. Relating our surroundings to society. 2. Relate to other workmen what work must be done.	1. Through known contours reservoirs can be best planned, highways built in the right place, and quantities of earth to be moved can be preplanned.

III. APPLICATION

A. Conduct field trip to job site and have students observe surveying crew determining elevations. Interview crew personnel to obtain general information in regard to this operation.

B. Students in groups of 2 or 4 should set up the level and stake out simple elevations.

IV. EVALUATION CRITERIA GUIDELINE

A. For what uses is the level employed?

B. What is meant by the term elevations?

C. What are stakes?

D. Perform the basic hand signals used in leveling.

E. What is a bench mark?

V. SUMMARY

A. The level is used in construction to determine the elevation of the job site. The level is most frequently used in laying out grades and sloping surfaces. Individuals who use the level generally have a working knowledge of the techniques used in the operation of the transit.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Introduction and motivation.

10 minutes . . . Prepare for field trip.

90 minutes . . . Field trip.

100 minutes . . . Student learning experiences.

120 minutes . . . Related concepts in science, math, communications and social studies.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

INSTRUCTOR'S UNIT PLAN

Unit 20
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPO[illegible]ATION

DIVISION: FARM and EARTHMOVING EQUIPMENT

SUBJECT: **The Use of the Transit in Construction**

AIM: To be able to set up, adjust and layout construction sites through the use of the transit.

INSTRUCTIONAL AIDS:

Transparencies and handouts illustrating and describing the use of the transit for construction layout.

EQUIPMENT:

Construction transit and related equipment. Field trip to observe surveying on site.

PRIMARY REFERENCES:

1) Breed, Charles B. and Hosmer, G. L., **Surveying**, Vol. 1, New York: John Wiley & Sons, Inc., 1961.

I. INTRODUCTION and MOTIVATION

A. Explain and illustrate the need for laying out a job site as accurate as possible.

B. Prepare students to visit on-site surveying.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. The transit. 1. The telescope. a. Focusing screw	1. The objective lens. 2. The cross laws. 3. The eyepiece. a. Inverted image b. Erect image	1. Science of optics. a. Formation of an image b. Optical axis c. Principle focus d. Optical center
B. The compass.	1. Magnetic meridian. 2. Magnetic bearing. 3. True bearing. 4. Declination of the needle.	1. Develop the difference between true north and magnetic north.
C. The vernier. 1. The upper plate. 2. The lower plate. 3. The upper clamp. 4. The lower clamp. 5. The upper tangent screw. 6. The lower tangent screw.	1. Reading the vernier. 2. Which side to read. 3. The use of clamps and screws to insure an accurate measurement.	1. The division of the circle into 360 equal parts. 2. The divisions on the vernier.
D. The leveling head and footplate.	1. Transit head should always be level.	1. Descriptive geometry . . . the a. Level head will keep the telescope in the same plane as it rotates
E. Setting up the transit.	1. Use of the transit legs. 2. Level the transit. 3. Center the plumb bob with the sliding head. 4. Measurement of a horizontal angle.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Computation for magnifying . . . power. 2. Computation for field of view.	1. Signals used between survey party members.	1. Advancement of society through use of telescope in science.
1. Computations of angles and bearings.	1. Use of proper terminology in describing an angle or bearing.	1. The impact of the compass on man's explorations.
1. One revolution is equal to 360°. 2. One degree equals 60 minutes. 3. One minute equals 60 seconds.	1. How to describe an angle properly in degrees, minutes and seconds.	1. Same as above plus the increased mapping possibilities.

III. APPLICATION

A. Conduct field trip to job site where surveying is being done. Interview surveyors concerning the operation of the transit and the need for accurate layout.

B. Students in groups of 2 or 4 should set up transit and layout a simple rectangular plot.

IV. EVALUATION CRITERIA GUIDELINE

A. How many men usually compose a surveying team?

B. Why is it necessary to keep the transit head level?

C. What is the difference between true and magnetic north?

D. Identify three uses of the transit.

V. SUMMARY

A. The transit is used in the construction industry to layout the job site. Surveying crews, composed of 2 or 3 men, use a transit in order to accurately locate points for site construction.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Introduction and motivation.

10 minutes . . . Prepare for field trip.

90 minutes . . . Field trip to job site.

100 minutes . . . Student learning experiences.

120 minutes . . . Related study in science, math, communications and social studies.

20 minutes . . . Summary and discussion of field trip.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Davis, Raymond E. et al., **Surveying Theory and Practice**, New York: McGraw-Hill Book Company, 1966.

2) Kissam, Philip, **Surveying Practice**, New York: McGraw-Hill Book Company, 1966.

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Delco Moraine Power Brake Service Manual, Dayton, Ohio: Delco Moraine Division, General Motors Corporation, Current Edition.

Delco-Remy Test Specifications, DR-324S, S-1, S-2, Anderson, Ind.: Delco-Remy Division, General Motors Corporation, Current Edition.

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Farm Power Equipment, NRFEA Publications, Inc., 2340 Hampton Avenue, St. Louis Mo. 63139.

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Implement and Tractor, Implement & Tractor Publications, Inc., 1014 Wyandotte Street, Kansas City, Mo. 64105.

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